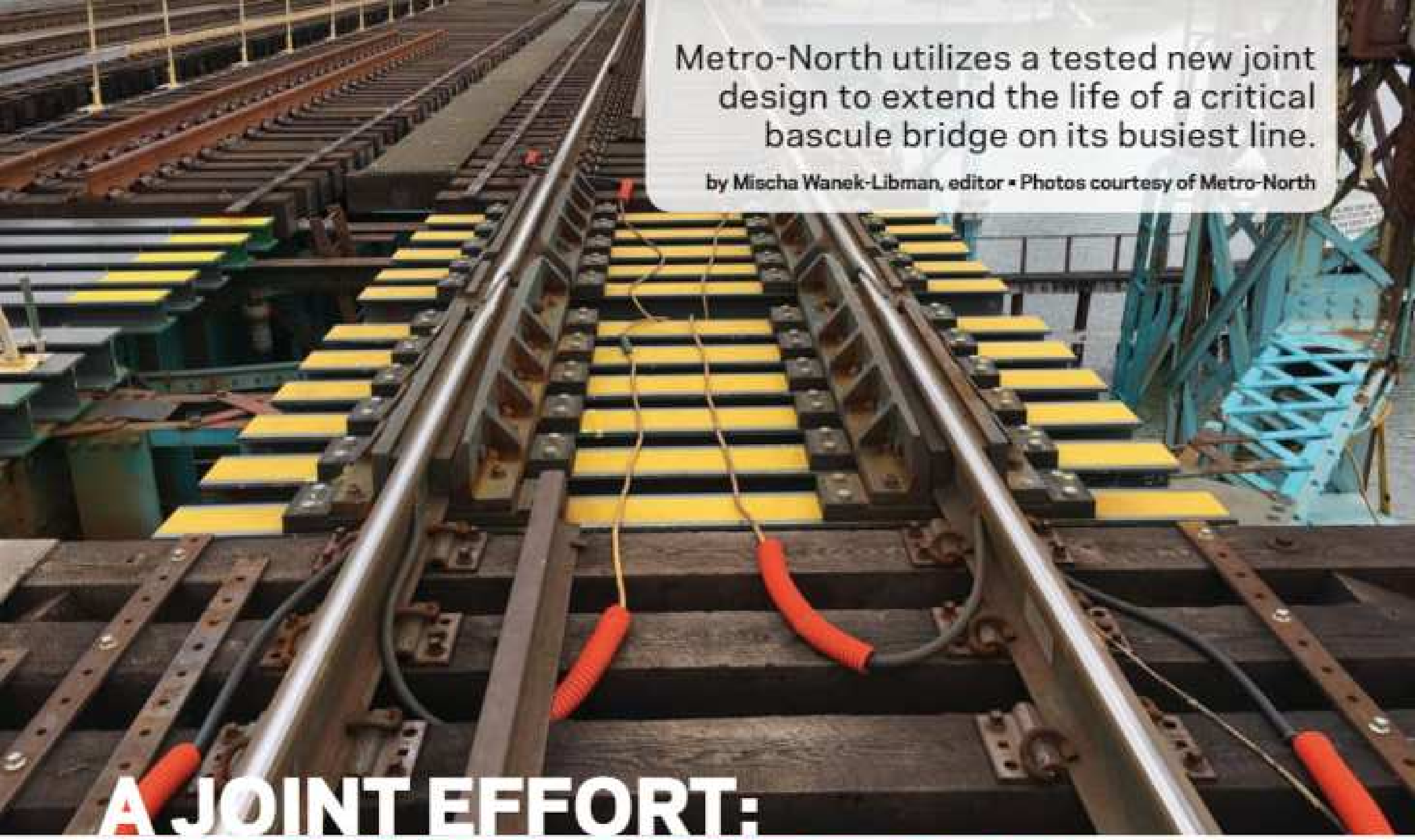

Metro-North utilizes a tested new joint design to extend the life of a critical bascule bridge on its busiest line.

by Mischa Wanek-Libman, editor • Photos courtesy of Metro-North

A JOINT EFFORT: COS COB MITER RAIL REPLACEMENT

The Cos Cob Bridge over the Mianus River in Greenwich, Conn., functions as a linchpin in two passenger rail systems: Metro-North Railroad's New Haven Line and Amtrak's Northeast Corridor (NEC).

Cos Cob is the busiest of the five movable bridges on the New Haven Line that the Connecticut Department of Transportation (CTDOT) owns and Metro-North maintains. The other four are the Walk Bridge over the Norwalk River in Norwalk, the Saga Bridge over the Saugatuck River in Westport, the Devon Bridge over the Housatonic River between Milford and Stratford and the Peck Bridge over the Pequonnock River in Bridgeport. CTDOT estimated in 2015 that a failure of one of these bridges, all more than 100 years old, would result in an added 125,000 daily commuters on the regions already congested highways.

Cos Cob's 11-span, 1,089-foot structure was originally built in 1904 and rehabilitated in 1989, but has reached the end of its functional life. The Scherzer rolling bascule span consists of two leafs, each carrying two tracks, while the remaining spans consist of four parallel bridges each carrying one track.

CTDOT defined a course of action to address the future serviceability needs of the Cos Cob Bridge and to maintain the long-term safety and reliability of rail service in the corridor. The project Metro-North is undertaking includes replacing the miter rails and deck timber, as well initial work on the design for the full replacement of the structure.

The first phase of the project included an in-depth inspection and load rating of the structure to assess the overall condition of the bridge and to identify structural and functional deficiencies. The second phase developed a design to address those deficiencies identified in the first phase.

HNTB provided consulting engineering services to prepare procurement and installation plans for new miter rails for the movable span and expansion rails on all four tracks of the Cos Cob Bridge. The plans were used by Metro-North forces to procure and install new expansion rails (two per track), miter rails (two per track) and related hardware for each of the four tracks on the bridge.

Following a review of the existing conditions of the bridge, HNTB made recommendations for the replacement of the existing miter rails. These recommendations included the use of thick-web all-rail miter joints; expansion rails to protect the new miter joints; steel ties and elastomeric direct fixation fasteners to support the miter rails with the expansion rails installed on dapped bridge timbers; the use of 2/0 (two aught) wire cable with plug coupler connections for continuity of the signal system and the replacement of all bridge timbers. The existing looped cables at the heel of the moveable span will be re-used, as will the proximity sensors at the toe and heel of the moveable span.

ABOVE: New miter rails installed on the Cos Cob Bridge. The bridge handles traffic for Metro-North's New Have Line, as well as Amtrak trains.

OUT WITH THE OLD: This image shows the old miter rails, which Metro-North is replacing on the Cos Cob Bridge.

Metro-North began work in the spring of 2016 to replace the existing miter rails, the bridge timbers on all tracks and install the expansion rails.

Existing miter joints

The existing miter joint rail currently installed on the Cos Cob Bridge, consists of two rails (one fixed, one movable) separated by an approximate two-inch gap. The rail ends are cut square and the head of one or both rails are depressed by about one quarter of an inch in two inches. To cross the gap, the wheel tread is transferred from the running rail to an elevated rider (or easer) rail that is mounted on the field side of the joint. The bed plates are typically four feet long and 20 inches wide and are furnished with a one to 40 cant. The standard design lifts a standard AAR1b wheel approximately one quarter of an inch above the running rail over a distance of about 13 inches. The running surface of the rider/easer block is 3/16 of an inch above the running rail, but due to the tapered tread of standard rail wheels, the amount that the wheel is lifted is less. Other passenger rail operators that use the bridge use a wheel with a non-standard taper. A modified design has been developed to be more compatible with these wheels, to reduce the impact loads generated by the transition from the running rail to and from the rider/easer block.

Disadvantages

Metro-North's engineering team notes that the primary disadvantage of this style of bridge joint is the amount of impact resulting from the transfer of the rail wheel to and from the running rails to the easer/rider rail. As the joint accumulates traffic, this impact causes wear and batter, which further amplifies the impact loading. Metro-North points to testing performed at Transportation Technology Center, Inc. (TTCI), that has shown that when new, miter/easer rails cause less of an impact than a standard bolted joint (±3 percent) at 30 mph, but that the impact is slightly higher, two percent, at speeds of 40 mph.

Metro-North says the thick-web miter joint, when new, was shown to have ±20 percent less impact than a standard rail joint at 40 mph or about 22-percent less impact than a new rider/easer block joint. The commuter railroad also notes that an additional concern with transferring the wheel from the rail to the rider/easer block is the sudden change in the location where the track contacts the wheel.

"Due to the taper of the tread, the radius of the wheel at the rail contact location is slightly larger at the rider/easer block contact location. When the train moving at a constant linear velocity crosses the joint, the rotational velocity of the wheel wants to change to adapt to the new contact radius. This will cause a small amount of slip between the wheel and the rail potentially leading to metal flow, rail defects and other undesirable wheel-rail interactions. Also, these joints have not proved a clear path for false flanges from worn wheels to bypass the rider/easer blocks. The loading from a wheel with a false flange would be transmitted further from the gauge line," said Dave Melillo, PE, director of Track and Structures at Metro-North.

Thick-web miter joints

Metro-North is replacing the existing miter joint rail with a new thick-web miter joint design, originally developed jointly between Amtrak and Cleveland Track Materials, Inc., now part of Vossloh, for use on the NEC.

Although developed for high-speed intercity passenger routes, the joints have been tested by TTCI at the Facility for Accelerated Service Testing (FAST) in Pueblo, Colo. Researchers installed a pair of joints on an open-deck steel bridge on the High Tonnage Loop that accumulated 201 million gross tons of 315,000-pound traffic.

A summary of the test, published by TTCI concludes that, "These joints lasted three to four times longer than the miter joints previously tested at the FAST. Very little maintenance was required until the joints were near the end of their service life."

Testing at TTCI showed that, when new, the thick-web miter joint generates ±20-percent less impact loading than a standard rail joint at 40 mph, which is about 21-percent less than what is created by a rider/easer style miter joint. The impact loading increased with the accumulation of traffic, from about 1.1 times the static wheel load to 1.44 times the static wheel load or about a 30-percent increase.

Melillo explains that this type of bridge joint is fabricated from rail bent and machined to an angled "miter" joint and is similar to earlier mitered bridge joints with the exception that it is constructed from the heavier thick-web rail and has heavier bed plates, bracing and guarding.

He notes that the joint is fabricated from a 136-thick-web rail section, includes flash-butt welded 136 RE extension rails, thick base plate assemblies and is fully guarded through the miter section. The bed plates for lift or bascule bridges are typically five feet long and 19.5 inches wide for direct fixation/steel tie installation or 30 inches wide for timber fixation. The standard joint is canted at one to 40.

The point of both rails are depressed 3/16 of an inch in five inches and no riser is included in the design.

Melillo says the original bridge joints installed on Cos Cob were "mitered" joints, but the angle of the miter was approximately 35 degrees compared to approximately six degrees for the thick-web miter joint.

He notes that this joint's primary advantage is the smooth transition from the approach rails to the lift rails, which occurs directly over a long angled miter cut. The joints are fully guarded and provided clear passage for false flanges from worn wheels.

The two-and-a-half-year project is on schedule with Track 4 completed in the fall of 2016. Work on Track 2 began in March 2017 and will be completed in August. Crews plan to begin work on Track 1 in September 2017 and Track 3 in spring 2018 with the entire project scheduled for completion in the fall of 2018. □

References

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